United States
Environmental Protection
Agency

Municipal Environmental Research
Laboratory
Cincinnati OH 45268

Research and Development

EPA-600/S2-84-158 Nov. 1984

EPA

Project Summary

City of Tampa: Management Analysis and Report System (MARS)

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This three-volume report describes the development and implementation of a management analysis and report system (MARS) in the Tampa, Florida, Water and Sanitary Sewer Departments. Original system development was based on research conducted in a smaller water utility in Kenton County, Kentucky. MARS will help both the Water and Sanitary Sewer Departments control costs and manage expanding service requirements more effectively and efficiently.

The objectives of MARS were (1) to provide computer programs that produce a MARS (compatible with the original research) for Tampa's Water and Sanitary Sewer Department; (2) to investigate the problems of scaling up from a small to a large system, including the problems of interfacing utility operations with a city financial reporting system; (3) to provide the mechanisms for establishing a self-sustained financial base for a wastewater utility (the water department of Tampa is already an enterprise system); (4) to convert the originally developed programs from an IBM 370* to a small stand-alone computer used only by the Water and Sewer Departments; and (5) to verify the system's satisfactory operation through practical application in Tampa.

The computer programming was accomplished with American Standard COBOL operating on a Prime Computer. This combination was chosen because of its widespread use and stand-alone capability.

MARS was able to meet project objectives and satisfy the reporting requirements of the Tampa Water and Sanitary Sewer Departments with information furnished monthly. The system is considered proven because it has produced reports as required in a stand-alone environment. However, substantial difficulties were encountered in interfacing MARS with the city's financial reporting system (FIN).

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

*Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Introduction

The Tampa Water and Sanitary Sewer Departments have developed and implemented a management analysis and report system (MARS) designed to help control costs and manage expanding service requirements. MARS is based on research conducted at the Kenton County (Kentucky) Water District No. 1 (KCWD) in which a cost analysis system (CAS) and a financial report system (FRS) were successfully developed and implemented. This report discusses the 2-year research effort—scaling up the cost and financial reporting systems to the Tampa Water Department and extending the concept to the Tampa Sewer Department. A key feature of this research was modification of the programs, originally developed to run on a large IBM mainframe computer in a time-sharing environment, to fit on a stand-alone computer (Prime). Volume I

is a general description of the project and provides background conditions and results. Volume II is an operations manual, and Volume III is a programming manual.

A prime feature of the Safe Drinking Water Act of 1974 (PL-93-523) is that the economics and cost of water supply and delivery must be considered before regulations are promulgated. In a 1974 study of water utilities, data were collected so that fundamental factors that affect the costs of water supply and utility management could be compared. After analyzing the data flow and information transfers from a number of large and small utilities, a technique, based on a matrix concept, was developed and tested by means of a water supply simulation model developed by the EPA Drinking Water Research Division in Cincinnati. This data collection and analysis technique was further refined at KCWD (Development and Application of a Water Supply Cost Analysis System, J. I. Gillean, W. L. Britton, Jr., J. H. Brim, and R. M. Clark, EPA-600/2-80-012a and 012b, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268).

Because of the success at the KCWD, EPA decided to verify the system's usefulness at a larger water utility, and Tampa was selected as the site. The Tampa Water Department had participated in EPA's 1974 cost studies, was aware of the successful application of the CAS at the KCWD, had recently expanded its treatment facilities, and was looking for a tool to assist in controlling costs. The Sanitary Sewer Department had also expanded, and their operational costs had increased.

Sanitary Sewer Department

The Tampa Sanitary Sewer Department, with 300-plus full-time employees, provides wastewater collection and treatment to persons and industries in the city and in nearby unincorporated areas. A system includes 130 pump stations and ejector stations drawing sewage from the service area; more than 1400 miles of 12-to 60-in.-diameter collection and transmission lines for the gravity system, a number of 4-in. force mains; metering at major interceptors or pumping stations and at the intake junction to the wastewater treatment facilities.

Generally, Tampa wastewater is processed through the Hooker's Point treatment plant with some flow receiving various levels of treatment at intermediate locations. Three Tampa users have pretreatment facilities: the Woodcrest, Juanita, and National Gypsum plants. Several residential developments have package plants serving a treatment function.

Water Department

The self-supporting Tampa Water Department, with about 250 full-time employees, supplies more than 419,500 people through 100,000 metered accounts (both residential and industrial) within an 84-square-mile service area. The Hillsborough River is the main raw water source (30 to 100 MGD). The main treatment facility, on the river, can treat a maximum of 100 MGD during periods of hard water/low coloration and a minimum of 75 MGD during periods of relatively soft water/high coloration. To serve a growing population, the city completed the Morris Bridge treatment plant and constructed 29 wells (500-ft-deep) each producing a maximum of 2 MGD. This facility, with a maximum treatment capacity of 40 MGD, provides water during high-demand periods.

The Matrix Concept

Regardless of physical structure, all water utility systems can be divided into the functions of acquisition, treatment, and delivery (Figure 1). For example, a well or a well field, rather than a reservoir, could be the source of raw water. Expansion of this concept allows costs to be identified both for specific functions (acquisition, treatment, and delivery) and for subfunctions. An acquisition subfunction might include source of supply, reservoir, pumps, transmission lines; a delivery subfunction, pumps, storage tanks, transmission, distribution.

By properly identifying these sublevels (including every part of the physical system with no overlapping areas) and by allocating costs to them, the complete physical utility becomes a group of cost centers. The cost center can be as small or as large as the utility wishes. As the water moves from its source to its destination, costs can be allocated to the water. In Figure 1, for example, acquisition consists of all costs for acquiring and moving raw water to the treatment plant. When the water is treated, it is assigned a treatment cost. The cost of treating the water can be added to the acquisition cost, which will be the cost for producing water at that point. Cost is also incurred by additional pumping within the treatment plant to move the water into the delivery area. Even though the pumping unit in the example is at the treatment plant, its purpose is to move water into the delivery area and is therefore considered a subfunction of delivery. Transmission and distribution costs are accumulated in each zone. The transmission costs are those for moving water to zones 1 and 2. Distribution costs include those for the network of mains and laterals that deliver water to customers within zones. An analysis of the system in Figure 1 reveals that part of the cost for pump No. 2 is allocated to move water through zone 1 to zone 2, and another portion of the cost is incurred in delivering water through the laterals to customers in zone 1. Similarly, the transmission mains include both a transmission cost element and a delivery cost element. Storage costs are assigned only to the zone in which the storage facility is located because no element of this cost is applied to any other zone.

Two types of costs were identified as the technique was refined. One type was associated directly with the operating functions of acquisition, treatment, and delivery, whereas the other type could not be identified with any specific operating function. The latter nonoperating costs (which include billing, accounting management, etc.) were placed in a separate category called support services, as shown in Figure 1.

Within this general concept, two basic types of information are required. If one thinks of a matrix of information, then on the horizontal axis are listed the specific functions of acquisition, treatment, delivery, and support services. These functions can be subdivided into the smallest component desired (for example, an individual pump), and they are related directly to the physical delivery system depicted in Figure 1. On the vertical axis of the matrix are the financial data that identify the cost items for operating the utility—labor, power, etc., generally recorded by a chart of accounts. Documentation of costs in this format makes it possible to retrieve and display the various levels or types of information desired. For example, the labor costs for treating water can be determined by examining the first cost category listed within the treatment function.

Output Reports

The first step in developing MARS was to identify the desired outputs. Four levels of cost reports were designed to provide information for specific levels of management, ranging from more detailed (for line supervision) to summary reports (for top administrators).

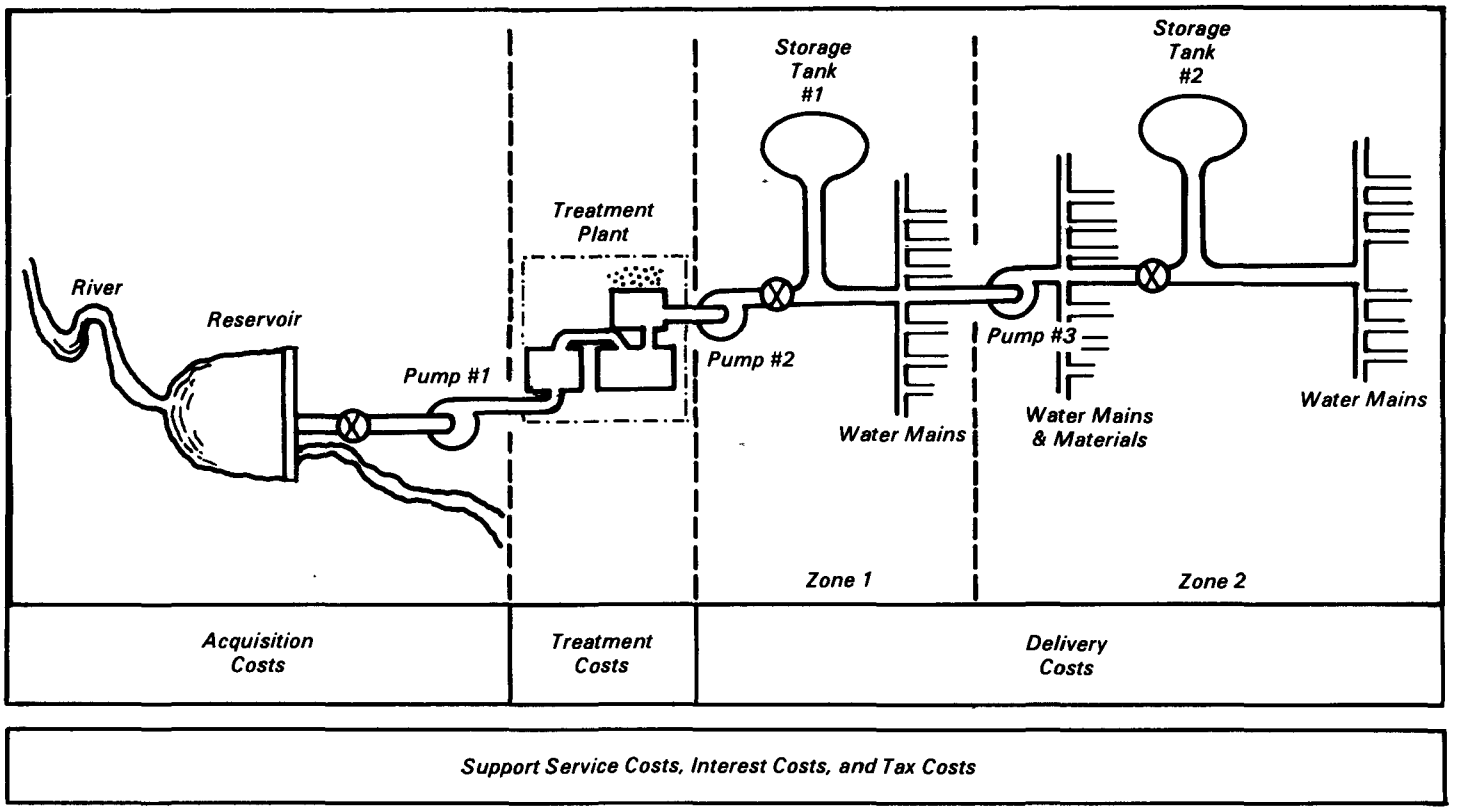

Figure 1. *Simplified schematic of a typical water utility.*

The Level IV report was developed to provide detailed cost information. The Level III report relates the detailed cost by the general, standardized categories of acquisition, delivery, etc. The Level II report compares actual expenditures with budgeted amounts and with expenditures for the previous year. The Level I report summarizes the cost data and identifies the cost per million gallons ($/MG) of revenue producing water (RPW) (RPW is the amount of water from which revenue was derived) for the major cost centers and the total cost of the system. Costs for the previous month, the previous year, and the budgeted amounts are also compared on the Level I report.

Cost Coding System

The cost coding system includes the chart of account numbers for the financial reporting system and the special code required for MARS. Three groups of numbers are required. The first group designates the general assignment to the National Association of Regulatory Utility Commissions (NARUC) chart of accounts.

The second group identifies the cost centers that generate the expense. The first digit of the cost center number identifies the function; the second, the subfunction; and the last two, the unit. The subfunction (second digit) and identification (third and fourth digits) appear only in the Level IV report.

The third group of numbers is a two-digit series corresponding to the 12 standard cost categories used in the Level III summary reports.

Cost Allocation

MARS can fulfill its function only when all cost data are charged to the appropriate cost centers. This task is done by identifying the correct cost center when the data are entered on the source document—that is, payroll time card, requisition from stock form, etc. Exceptions to this procedure occur when the cost center information is not obtained or when a general cost cannot be identified to a specific center. To deal with such exceptions, an allocation concept assigns costs to appropriate cost centers.

MARS Application to Wastewater

Conceptually, the adaptation of MARS to a wastewater operation proved no more difficult than its application to a water utility except for the initial definition of terms. As a water supply tool, MARS was designed to accumulate detailed cost into the four major functions of acquisition, treatment, delivery, and support services. This structure of four major cost categories was maintained throughout the entire study for the water supply application. For wastewater application, these terms are not appropriate. For example, the basis for productivity in the water supply application is revenue-producing water; in wastewater, there is no equivalent value. Therefore in developing the terms for wastewater utility functions, the following two groups were selected:

A. Collection – All costs associated with moving wastewater to the treatment facility.

Treatment – All costs associated with removing the impurities

from wastewater and with preparing the impurities for disposal.

Disposal – All costs associated with disposing of the liquids and solids after treatment.

Support Services – All costs associated with support activities related to the utility that are not a part of the above three areas.

B. Collection – All costs associated with moving wastewater to the treatment facility.

Treatment Liquid – All costs associated with the liquid portion of the treatment process where impurities are being removed.

Solid – All costs associated with the solids portion of the treatment process where the impurities are being conditioned.

Support Services – All costs associated with support activities related to the utility that are not a part of the above two areas.

The differences in the liquid and solid treatments (Approach B above) are illustrated in Figure 2, which depicts the wastewater treatment process in the Tampa plant. The processes in the vertical stack of boxes on the left side of Figure 2 describe the liquids treatment since they are all related to handling liquids and removing their impurities. The horizontal lines identifying function, such as sludge thickening and drying beds, are associated with solids that have been removed from the liquid wastewater. With this method, definitive costs can be obtained from the different treatment processes and can be identified on all levels of reports as associated with liquid and/or solids treatment. The problem with this approach is the requirement for recording detailed source data. Record keeping may become difficult because two processes sometimes occur at the same physical location.

Approach A has the advantage of being able to identify the treatment process to any detail desired (including separation of the liquids and solids) in Level IV of the MARS report. The only disadvantage is that it does not identify the liquids and solids cost in the higher level reports but accumulates them into a total treatment cost. Tampa Sanitary Sewer Department personnel preferred Approach A because they believed it provided more flexibility in identifying the treatment cost based on the process configurations most meaningful to them. Treated wastewater was selected as the expression for productivity (unit value) to be used in MARS since it represents the actual flow through the treatment facility.

All other problems associated with MARS application to wastewater are similar to those that may be expected in application of MARS to any utility. For example, some of the output reports from the sewer and water departments were structured differently.

The reporting differences reflected individual management philosophies as much as differences between water and wastewater operations.

Tampa's Financial Reporting System (FIN)

FIN was developed to streamline input requirements by using on-line terminals that validate and edit input data as they enter into the data base files. The objective of FIN is to provide the detailed information required for the highest levels of management and budgeting. FIN is based on Florida's standardized system of accounts and each coding element has its unique meaning and identification within the city's financial system.

The data for FIN originate from many different sources, such as the Purchasing Department. Figure 3 shows the general data flow through FIN and some of its

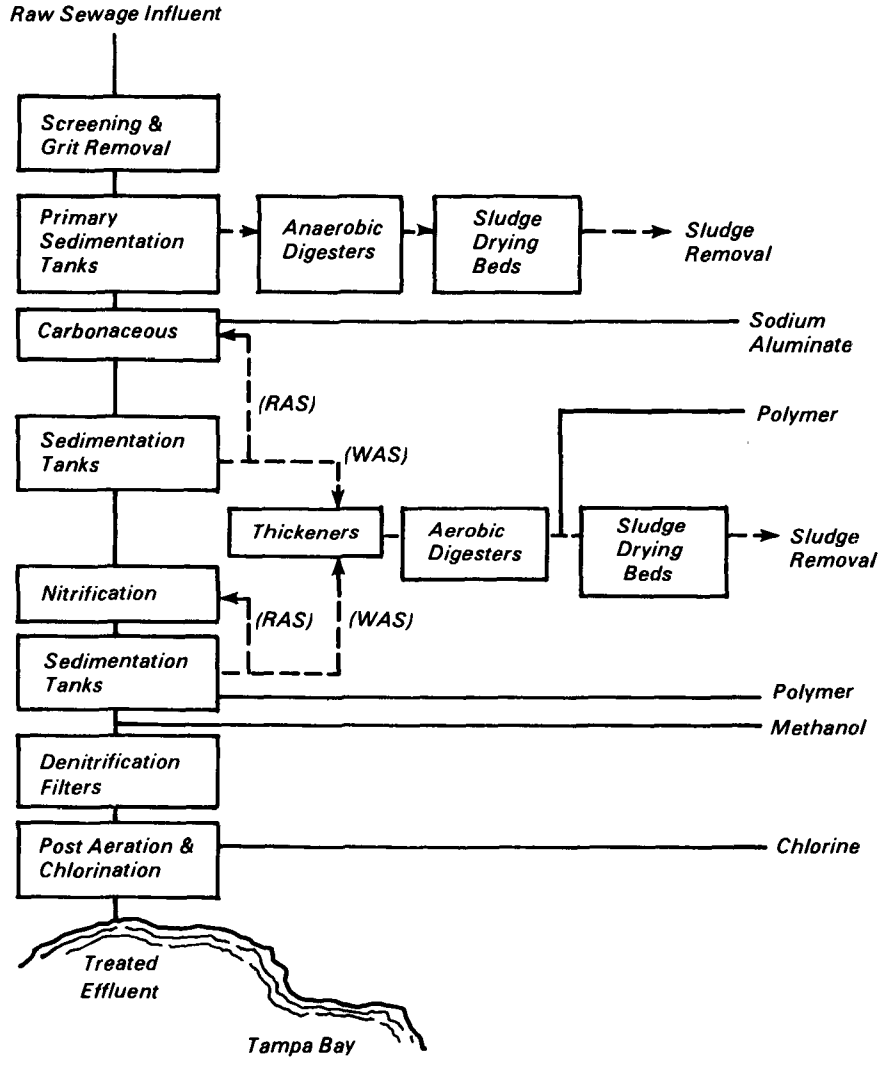

Figure 2. Schematic of Hooker's Point Wastewater Treatment Plant in Tampa, Florida. RAS refers to recycled activated sludge; WAS, to waste activated sludge.

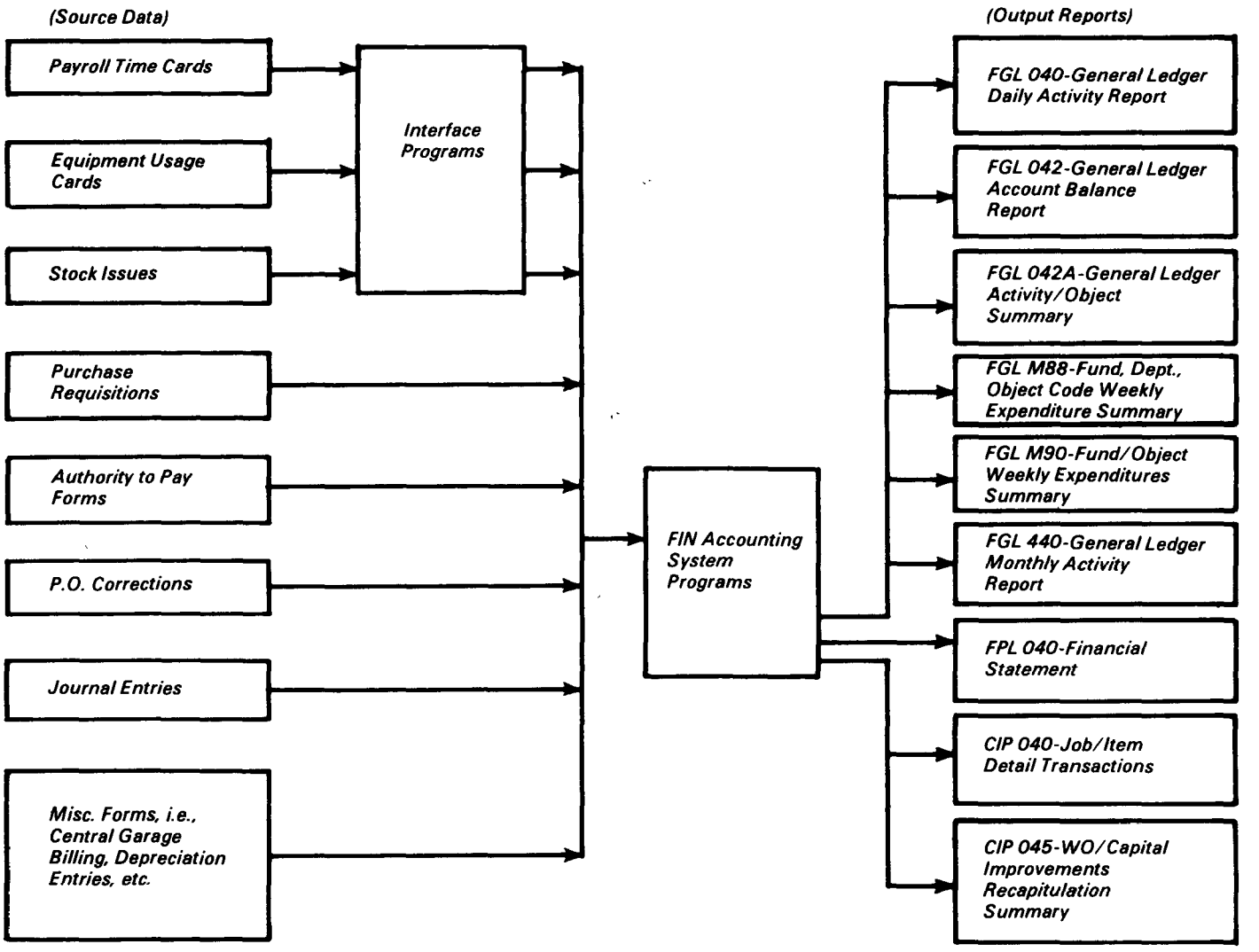

Figure 3. *General flow diagram for Tampa's financial reporting system (FIN).*

output reports. FIN coding uses a pyramid structure in which a transaction enters at the lowest level and is automatically accumulated through higher levels of activities. The information varies with the type of transaction, but all of the latter normally share the common key fields that interpret and categorize the data. These fields create the account number and consist of the fund, department, etc.

The system enables management to identify and accumulate data on like items from all budgeting elements for the fiscal cycle. Management in turn can solicit bids valid for specific periods, establish firm prices, and identify individual vendors for various purchases.

The overall concept of FIN is to establish a detailed data base on a daily basis, thereby creating a voluminous and complex system. Within FIN, the budget is developed to the lowest level of a product code. For example, consider purchasing a 75W, inside frosted, 130V incandescent lamp. If this item is budgeted but the department decides later to purchase a clear lamp rather than a frosted one, a budget change is required. The system may thus require numerous budget changes each month.

FIN was primarily developed from the standpoint of accounting and fiscal management, not from that of an operational department. Such an overall approach may be the best for the city, but a system developed in this manner generally lacks the type of information useful to operational management. For example, the major systems developed for FIN include revenue and cash management, expenditure management (accounts payable), purchasing, inventory management, and fixed assets. All of these systems are certainly important to a department, but they do not include cost-center information for managing departmental operations.

FIN's original development included coding flexibility at departmental levels using the job/item fields. However, to make proper use of this flexibility, the department needs an in-depth understanding of FIN. Without major modifications, it would be difficult to obtain from FIN much of the information needed for day-to-day management of a water and wastewater department.

Computer Selection

A computer selection committee was appointed consisting of a consultant and a representative from the Sanitary Sewer Department, the Water Department, and the Management and Information System Department (city computer center). The objective of the committee was to identify for Tampa's Water and Sanitary Sewer Departments the best computer hardware and operational software to support both the MARS project and other applications within these departments. The Prime computer was selected based on its reliable and proven software—an especially important factor in the development of new programs such as MARS.

MARS Report

The MARS reports are specifically designed for top utility management. They contain operating and maintenance cost data summarized into major operational categories along with additional information useful in evaluating the operations of the entire utility.

An example of a Level I report for the Water Department appears in the computer print-out shown in Figure 4. The first five rows contain cost data expressed on a productivity basis with dollars per million gallons of water ($/MG) for the: (1) current month, current year, (2) previous month, current year, (3) current month, previous year, (4) year-to-date, current year, and (5) year-to-date, previous year. These unit costs may be compared to facilitate a trend analysis.

The next two rows contain the total costs for the current month and year-to-date, and the last two rows provide a percentage of total cost for each function for the current year-to-date and the previous year-to-date. This information provides an indication of shifts in cost and/or trends in areas where expenses are changing.

Production unit cost information is presented at the bottom of the page, along with percent of budget funds remaining. The production unit for the Water Department is classified as "revenue-producing

MONTH ENDING: JAN 31, 1982

SUMMARY OF SYSTEMS INFORMATION
FOR
TAMPA WATER DEPARTMENT
(LEVEL I)

PAGE: 1

CATEGORY	ACQUISITION	PURIFICATION	DELIVERY	SUPPORT	DEBT EXPENSE	DEPRECIATION	TOTAL
UNIT COST $/MG							
CURRENT MONTH	$ 9.21	$ 124.97	$ 228.16	$ 202.85	$ 158.67	$ 101.74	$ 825.60
PREVIOUS MONTH	7.28	159.23	175.07	70.62	157.95	96.06	666.21
CURRENT MONTH PREVIOUS YEAR							
CURRENT YEAR (YTD)	8.96	143.64	220.46	96.69	164.09	96.53	730.37
PREVIOUS YEAR (YTD)							
TOTAL COST							
CURRENT MONTH	$ 15,312.49	$ 207,818.07	$ 379,415.35	$ 337,328.68	$ 263,860.15	$ 169,176.94	$ 1372,911.68
YEAR TO DATE	60,430.23	968,306.22	1486,111.17	651,785.36	1106,106.74	650,725.91	4923,463.83
PERCENTAGE OF TOTAL							
CURRENT YEAR (YTD)	1.23%	19.67%	30.18%	13.24%	22.47%	13.22%	100.00%
PREVIOUS YEAR (YTD)							

TREATED WATER (MG)		REVENUE PRODUCING WATER (MG)	
CURRENT MONTH	1687.431	CURRENT MONTH	1662.910
YEAR TO DATE	7340.196	YEAR TO DATE	6740.982
PREVIOUS Y-T-D	7261.631	PREVIOUS Y-T-D	6894.851
UNACCOUNTED FOR WATER (MG)		BUDGET REMAINING (%)	
CURRENT MONTH	24.521	YEAR TO DATE	66.10
YEAR TO DATE	799.214		

Figure 4. Level I status report for Tampa Water Department.

water," (the Sanitary Sewer Department uses "Billable Q," or billed sewer line flow into the treatment facility).

Conclusions

The following conclusions are based on the MARS experience in Tampa.

1. MARS was less adaptable to the Tampa utilities than anticipated, for the following reasons:
   a. MARS was originally developed using the KCWD and other wate utilities as models, but FIN was so inflexible that the original MARS and some basic developmental concepts had to be modified to function with FIN.
   b. Because of the size of the Tampa utility's operation, significantly more data entered this system than in the smaller KCWD. Consequently, MARS required larger system files for data processing and storage, along with different data handling techniques.
   c. Modifying the original computer programs from a batch mode on the large main-frame computer to an automatic interactive mode on a small computer proved difficult. These modifications combined with conceptual program changes required careful planning and considerable additional programming effort.
2. The MARS concepts are transferable, as demonstrated by adapting the original four levels of the KCWD reports to both the Water and Sanitary Sewer Departments in the same general format.
3. Adapting MARS to the Tampa wastewater operation was no more difficult than applying it to the Tampa water utility. The Tampa application disclosed enough differences between water and wastewater operations to merit water-unique and wastewater-unique programs in future applications. If the water and wastewater operations can be integrated under a single fiscal manager, it may be possible to use one group of programs.
4. The use of Prime 250 or equivalent computer hardware for the MARS application is evidenced by successful operation on the Prime computer. Since a financial reporting system already existed in Tampa, MARS consisted only of the cost analysis and management information module. The processing time on the computer will probably require approximately 1 or 2 days per month (if monthly reports are required), leaving the computer idle for the remainder of the month except as a means of data storage. However, both Tampa departments have numerous other computer programs that were intended to operate on the same computer system. Thus in a situation that requires only the cost analysis module of MARS, justifying the use of a small computer is questionable. A more reasonable option may be to operate this system on remote, time sharing hardware.
5. The ease or difficulty of adapting MARS to other water and wastewater utilities depends on site-specific conditions. Solving the MARS/FIN interface at Tampa consumed more time than was originally anticipated.
6. MARS assisted in detecting data errors that existed in FIN. The MARS programs edit each FIN expense item to ensure that the code is correct with respect to the requirements of MARS. If the code is erroneous, the item is listed for correction. To maintain a balance, data corrected in MARS must also be corrected in the original system (FIN) that feeds data into MARS.
7. The value of MARS for Tampa Water and Sanitary Sewer Departments has not yet been completely evaluated because the MARS reports have been available for only a short period.

The full report was submitted in fulfillment of Cooperative Agreement CR-807440 by the City of Tampa Water and Sanitary Sewer Departments under the sponsorship of the U.S. Environmental Protection Agency.

*USGPO: 1984-559-111-10730

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The complete report consists of three volumes entitled "City of Tampa: Management Analysis and Report System (MARS):

"Volume I (Case Study)," (Order No. PB 85-106 177; Cost: $14.50, subject to change).

"Volume II (Operations Manual)," (Order No. PB 85-106 185; Cost: $14.50, subject to change).

"Volume III (Programming Manual)," (Order No. PB 85-112 241; Cost: $46.00, subject to change).

The above reports will be available only from

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